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Shunpei YAMAZAKI et al.

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For: A METHOD OF MANUFACTURING  
DISPLAY DEVICE

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VERIFICATION OF TRANSLATION

Commissioner for Patents

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Sir:

I, Satomi Hata, C/O Semiconductor Energy Laboratory Co., Ltd. 398, Hase, Atsugi-shi, Kanagawa-ken 243-0036 Japan, herewith declare:

that I am well acquainted with both the Japanese and English Languages; and

that to the best of my knowledge and belief the following is a true and correct English translation of the Japanese Patent Application No. 2003-028931 filed on February 5, 2003.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 28th day of December, 2006

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[List of Attachment]

25 [Attachment] Specification 1  
[Attachment] Drawing 1  
[Attachment] Abstract 1

[Proof] required

[Name of Document] Specification

[Title of the Invention] MANUFACTURING METHOD OF DISPLAY DEVICE

[Scope of Claims]

[Claim 1]

5           A manufacturing method of a display device, which uses droplet emitting means which uses a droplet emitting head in which one or a plurality of droplet emitting holes are disposed, and plasma processing means for carrying out local plasma processing which has plasma generating means generating plasma under atmospheric pressure or the vicinity of atmospheric pressure, and

10           the manufacturing method of a display device, characterized by forming a pattern which comprises a composition which is emitted by use of the droplet emitting means, and by carrying out plasma processing to the pattern by use of the plasma processing means.

[Claim 2]

15           A manufacturing method of a display device, which uses droplet emitting means which uses a droplet emitting head in which one or a plurality of droplet emitting holes are disposed, and plasma processing means for carrying out local plasma processing which has plasma generating means generating plasma under atmospheric pressure or the vicinity of atmospheric pressure, and

20           the manufacturing method of a display device, characterized by carrying out formation of resist and wiring by use of the droplet emitting means, and by carrying out ashing of the resist and etching of the wiring by use of the plasma processing means.

[Claim 3]

25           A manufacturing method of a display device, which uses droplet emitting means which uses a droplet emitting head in which one or a plurality of droplet emitting holes are disposed, and plasma processing means for carrying out local plasma processing which has plasma generating means generating plasma under atmospheric pressure or the vicinity of atmospheric pressure, and

30           the manufacturing method of a display device, characterized by carrying out formation of resist by use of the droplet emitting means, and by carrying out ashing of the resist and etching of wiring by use of the plasma processing means.

[Claim 4]

A manufacturing method of a display device characterized in that, as the droplet in claims 1 through 3, used is any one of a photosensitive resist, a paste form metal material or organic liquid solution which includes the paste form metal, a  
5 ultra-fine particle form metal material or organic liquid solution which includes the metal material.

[Claim 5]

A manufacturing method of a display device, which uses plasma processing means which has plasma generating means generating plasma under atmospheric  
10 pressure or the vicinity of atmospheric pressure, for carrying out local plasma processing, and

the manufacturing method of a display device, characterized by forming wiring, by carrying out etching an electric conductive film, which is formed on a substrate to be processed, by use of the plasma processing means.

15 [Claim 6]

A manufacturing method of a display device, which uses droplet emitting means which uses a droplet emitting head in which a plurality of droplet emitting holes are disposed in a line form, and

the manufacturing method of a display device characterized by forming a  
20 groove part in an insulating film which is formed on a glass substrate, emitting a composition in the groove, by use of the droplet emitting means, and forming a pattern which comprises the composition along the groove, thereby it being used as a wiring.

[Claim 7]

A display device having a glass substrate, a first thin film which is formed on  
25 the glass substrate, a pattern which comprises a composition which is emitted on the first thin film, and a second thin film which is formed on the pattern, and

a manufacturing method of the display device characterized in that the pattern is emitted by droplet emitting means which uses a droplet emitting head in which one or a plurality of droplet emitting holes are disposed in a line form, and formed in a matrix  
30 form.

[Claim 8]

A manufacturing method of a display device, including

a process of emitting an electric conductive film, which becomes a wiring, on a substrate, by use of droplet emitting means,

a process of forming a resist pattern by emitting a resist on the electric conductive film by use of the droplet emitting means,

5 a process of carrying out etching of the electric conductive film with the resist pattern as a mask, by use of plasma processing means, and

a process of carrying out ashing of the resist pattern by use of the plasma processing means, to form a wiring, and

10 the manufacturing method of a display device characterized in that the droplet emitting means is equipped with a droplet emitting head in which one or a plurality of droplet emitting holes are disposed in a line form, and

the plasma processing means has plasma generating means generating plasma under atmospheric pressure or the vicinity of atmospheric pressure for carrying out local plasma processing.

15 [Claim 9]

A manufacturing method of a display device characterized in that, as the droplet in claims 5 through 8, used is any one of a photosensitive resist, a paste form metal material or organic liquid solution which includes the paste form metal, a ultra-fine particle form metal material or organic liquid solution which includes the metal material.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention pertains]

25 This invention relates to a manufacturing method of a display device which uses droplet emitting means and an atmospheric pressure plasma processing method.

[0002]

[Prior Art]

30 Manufacture of circuit patterns of thin film transistors (TFT) etc. which are included in a display device typified by a liquid crystal display device (LCD) and a light-emitting display device (EL(Electro-Luminescence)) display device) has used a vacuum process which is carried out in such a status that an inside of a processing

apparatus is in reduced pressure or vacuum, and a photolithography process in which a mask, which comprises a (photo) resist, is manufactured by a light exposure apparatus and an unnecessary portion is removed by etching. (See, Patent Document 1)

[0003]

5 (Patent Document 1) JP-A-2002-359246 publication

[0004]

The vacuum process requires air discharging means for forming a vacuum or reducing a pressure of a process chamber for carrying out film formation, etching etc. for a substrate to be processed. The air discharging means is composed of a pump typified by a mechanical booster pump and a turbo molecular pump, an oil rotation  
10 pump etc., which are disposed outside a processing apparatus, means which manages, controls them, and also, piping and valves etc. which couples the pump and a processing chamber to configure an air discharging system. In order to lay out the equipment, a space for the air discharging system becomes necessary outside the processing  
15 apparatus, and costs for the same become also necessary. Further, since it is also necessary to mount equipment of the air discharging system to the processing apparatus itself, a size of the processing device becomes larger as compared to a thing on which the air discharging system is not mounted.

[0005]

20 A photolithography process which has been used since a long time ago, for circuit pattern formation of thin film transistors etc., e.g., a photolithography process for wiring formation is carried out as follows. First, a photosensitive resist (photo resist) is spin-coated on an electric conductive film which is formed on a substrate, and thereby, the resist is spread out on the whole surface of the electric conductive film. Next, light  
25 irradiation is carried out through a photo mask on which a pattern is formed by metal, to expose the resist to light. Subsequently, development and post bake are carried out, to form a resist pattern with a pattern shape of the photo mask. Further, by use of the resist which is formed in a pattern shape as a mask, etching processing is applied to the electric conductive film under the resist. Finally, the resist pattern, which is used as  
30 the mask, is peeled off, and thereby, it is possible to carry out etching of the electric conductive film, in a pattern shape formed on the photo mask, and a remaining electric conductive film is used as wiring.

[0006]

[Problem to be Solved by the Invention]

However, in the vacuum process in the prior art, in connection with size growing of a meter square size of fifth, sixth generations or later, a volumetric of a process chamber also expands. Here, the fifth generation means a mother glass substrate size of 1000X1200mm<sup>2</sup>, and the sixth generation means a mother glass substrate size of 1400X1600mm<sup>2</sup>. On this account, in order to run the process chamber into a vacuum or reduced pressure status, larger-sized air discharging system becomes necessary, and also, time necessary for air discharge also increases. Further, also in a cost phase, equipment cost and maintenance cost etc. of the air discharging system mount up. In addition, also in a case of replacing the chamber with gas such as nitrogen, a much more amount of gas becomes necessary because of volume increase of the chamber, which has an influence on production cost. Further, in connection with size growing of the substrate, huge running costs are required for power supply etc., and therefore, it results in increase of environment burdens.

[0007]

Further, in a process which uses a photolithography process in the prior art, e.g., a wiring manufacturing process, a large portion of a coated film (resist, metal, semiconductor etc.) which is formed on a whole surface of the substrate is removed by etching, and a proportion that wiring etc. remain on the substrate, has been a range of several to several dozen %. On the occasion of forming a resist film by spin coating, approximately 95% has been wasted. In short, a most part of a material is to be thrown away, which not only has an influence on production cost, but also invites increase of environmental burdens. Such trend becomes obvious as a substrate, which flows on a production line, grows in size.

[0008]

[Means for Solving the Problem]

In order to solve the above-described problems of the prior art, the invention applies a method in which a resist and a wiring material are emitted directly to a necessary place on a substrate as droplets, to draw a pattern. Further, a method in which carries out a gas phase reaction process such as ashing and etching under atmospheric pressure or in the vicinity of atmospheric pressure are locally carried out is

applied. By applying these methods, it is possible to significantly reduce quantity of gas consumed which is used for a coated film material (resist, metal, semiconductor, etc.) and the gas phase reaction process, which have been the conventional object.

[0009]

5 In the invention, as the above-described droplet emitting means, a droplet emitting apparatus having a droplet emitting head in which one or a plurality of droplet emitting holes is disposed is used.

[0010]

10 Further, in the present invention, as the plasma processing method for carrying out the above-described gas phase reaction process, used is a plasma processing means which has plasma generating means under atmospheric pressure or in the vicinity of atmospheric pressure, to carry out local plasma processing.

[0011]

15 The above-described means which emits droplets, or the above-described gas phase reaction process is designed to be carried out under atmospheric pressure or in the vicinity of atmospheric pressure. On that account, it becomes possible to omit an air discharging system for realizing a vacuum or reduced pressure status in a process chamber, which is required in a conventional vacuum process. Therefore, it is possible to simplify the air discharging system which grows in size based on size growing of a substrate, and it is possible to reduce equipment cost. In accordance with this, it becomes possible to suppress energy etc. for discharging air, which results in reduction of environmental burdens. Further, since it is possible to omit time for air discharge, tact time is improved, so that it becomes possible to carry out production of a substrate more effectively.

25 [0012]

[Embodiment Modes of the Invention]

(Embodiment Mode 1)

30 Embodiment Mode 1 of the invention, by using a droplet emitting apparatus which has a droplet emitting head in which one or a plurality of droplet emitting holes are disposed and plasma generating means generating plasma under atmospheric pressure or the vicinity of atmospheric pressure, manufactures a wiring pattern which is indispensable as a display device, on a glass substrate with a desired size using the



plasma processing apparatus performing the local plasma processing. In particular, the invention intends to be applied to a meter square substrate of fifth, sixth generations or later, which grows in size. Hereinafter, Embodiment Mode 1 will be explained with reference to Fig.1.

[0013]

First, by use of a publicly known method, for example, a sputter or CVD method (Chemical Vapor Deposition method), an electric conductive film, which becomes wiring, is formed on a substrate 1001 to be processed (Figs.6(A)). Next, by use of a dot form droplet emitting apparatus which will be described later, a resist pattern 1003 is formed on a part where a wiring pattern is formed (Fig.6(B)). The resist pattern 1003 is formed as a line form pattern, by overlapping droplets which are emitted from dot form droplet emitting holes, and then, emitting them. However, it is not limited to the line form, but it is also possible to form in an arbitrary pattern. Next, by use of the baked resist pattern as a mask, and by use of a plasma processing apparatus which will be described later, an conductive film 1002, which is not covered with the resist pattern 1003, is etched (Fig.6(D) and Fig.6(E)). The etching is carried out by scanning the plasma generating system, in such a manner that dot form plasma generating system comes to an arrow position in Fig.6(D). At this time, as etching gas, used is gas which reacts with an electric conductive film. After the etching processing, ashing is applied to the remaining resist pattern 1003 by use of the dot form atmospheric pressure plasma processing apparatus, to remove it. Scanning of the plasma generating system at the time of ashing is carried out in the same manner as at the time of the etching. As a result, only an electric conductive film remains at a resist pattern forming place, and a wiring pattern is formed (Fig.6(F)). Meanwhile, highly reactive oxygen is used as gas at the time of ashing. A fluorinated acid based gas may be used instead to increase reactivity.

[0014]

Hereinafter, a droplet emitting apparatus used in the embodiment mode 1, which has a droplet emitting head in which one or a plurality of droplet emitting holes are disposed, will be described with reference to accompanying drawings. Fig.1 is schematic perspective view which shows as to one configuration example of the dot form droplet emitting apparatus, and also, Figs.2, Figs.3 are views which shows as to

the head part used for this dot form droplet emitting apparatus, in which nozzles are disposed.

[0015]

The dot form droplet emitting apparatus shown in Fig.1 has a head 106 in the apparatus, and droplets are emitted by the head 106, and thereby, a desired droplet pattern is obtained on a substrate 102. In the dot form droplet emitting apparatus, as the substrate 102, it is possible to apply to an object to be processed such as a resin substrate typified by a plastic substrate, or a semiconductor wafer typified by silicon, in addition to the glass substrate with a desired size.

[0016]

In Fig.1, the substrate 102 is carried from a carry-in entrance 104 in an inside of a housing 101, and the substrate, for which droplet emission processing is finished, is carried out from a carry-out outlet 105. In the inside of the housing 101, the substrate 102 is mounted on a carrier table 103, and the carrier table 103 moves on rails 110a, 110b which connect the carry-in entrance and the carry-out outlet.

[0017]

Head support parts 107a and 107b are a mechanism which supports a head 106 which emits droplets, and moves the head 106 to an arbitrary position in an X-Y plane. The head support part 107a moves in an X direction which is in parallel with the carrier table 103, and the head 106, which is mounted on the head support part 107b fixed to the head support part 107a, moves in a Y direction which is perpendicular to the X direction. When the substrate 102 is carried in an inside of the housing 101, at the same time as this, the head support part 107a and the head 106 move in the X, Y directions, respectively, and are set up to an initial predetermined position for carrying out droplet emission processing. The movement of the head support part 107a and the head 106 to an initial position is carried out at the time of substrate carry-in, or at the time of substrate carry-out, and thereby, it is possible to carry out emission processing effectively.

[0018]

The droplet emission processing is started when the substrate 102 reaches to a predetermined position, by the movement of the carrier table 103. The droplet emission processing is accomplished by a combination of relative movement of the

head support part 107a, the head 106 and the substrate 102, and droplet emission from the head 106 which is supported by the head support part. By adjusting moving speed of the substrate, the head support part and the head, and a cycle for emitting droplets from the head 106, it is possible to draw a desired droplet pattern on the substrate 102.

5 In particular, the droplet emission processing requires high accuracy, and therefore, it is desirable that movement of the carrier table 103 is stopped at the time of droplet emission, and only the head support part 107a and the head 106 with high controllability are scanned. It is desirable to select a drive system with high controllability, such as a servo motor and a pulse motor, for drive of the head 106 and the head support part 107a.

10 In addition, respective scanning of the head 106 and the head support part 107a in an X-Y direction is not limited to only one direction, but it would be fine if the droplet emission processing is carried out, by carrying out to-and-from or repetition of to-and-from. By the above-described movement of the object to be processed and the head support part, it is possible to emit droplets to a whole area of the substrate.

15 [0019]

The droplets are supplied from a droplet supply part 109 which is disposed outside the housing 101, to an inside of the housing, and further, supplied through the head support parts 107a, 107b to a liquid chamber in an inside of the head 106. This droplet supply is controlled by control means 108 which is disposed outside the housing

20 101, but may be controlled by control means which is built in the head support part 107a in the inside of the housing.

[0020]

The control means 108 has major functions such as movement of the carrier table, the head support part and the head, and control of droplet emission which

25 responds to this movement, in addition to the above-described control of droplet supply. Further, it is possible to download data of pattern drawing by droplet emission, from an outside of the apparatus through software such as CAD, and these data are inputted by methods of a graphic input and a coordinate input, etc. Still further, a mechanism for detecting a remaining amount of a composition which is used as droplets is disposed in

30 the inside of the head 106, to transfer information which shows the remaining amount to the control means 108, and thereby, an automatic remaining amount warning function may be added.

[0021]

Although it is not described in Fig.1, further, it would be fine if a sensor for alignment of the substrate and the pattern on the substrate, means for introducing gas into the housing, air discharging means for the inside of the housing, means for carrying out heat treatment for the substrate, means for irradiating light to the substrate, and in addition, means for measuring various values of physicality such as temperature and pressure are also disposed according to need. Further, it is also possible to control these means collectively by the control means 108 which is disposed outside the housing 101. Further, if the control means 108 is connected to a production management system etc. by a LAN cable, wireless LAN, an optical fiber, etc., it becomes possible to uniformly manage processes from an outside, which results in improving productivity.

[0022]

Next, a configuration of the inside of the head 106 will be explained. Figs.2(A) is a cross-section view of the head 106 of Fig.1, which is in parallel with the Y direction, and Figs.2(B) is a perspective view which shows a scanning direction of the head 106, together with an example of wiring formation due to droplet emission.

[0023]

In Fig.2(A), droplets which are supplied from an outside to an inside of a head 201, after they pass through a liquid chamber flow path 202 and are stored in an auxiliary liquid chamber 203, move to a nozzle 209 for emitting droplets. A nozzle part is composed of a fluid resistance part 204 which is disposed so as for moderate droplets to be loaded in the nozzle, a compressing chamber 205 for compressing droplets and emitting them to an outside of the nozzle, and a droplet emitting hole 207.

[0024]

On a side wall of the compressing chamber 205, disposed is a piezoelectric element 206 which has PIEZO electric effect, such as titanate acid-zirconium acid-lead( $\text{Pb}(\text{Zr,Ti})\text{O}_3$ ) deformed by applied voltage. On this account, by applying a voltage to the piezoelectric element 206 which is disposed on a target nozzle, the piezoelectric element is transformed, and an inner volume of the compressing chamber 205 is lowered, and thereby, droplets are pushed out, and it is possible to emit a droplet 208 to an outside.

[0025]

In the invention, the droplet emission is carried out by a so-called PIEZO system which uses a piezoelectric element, but depending on a material of droplets, a so-called thermal ink-jet system, in which a heating element is heated to generate air bubbles and to push out droplets, may be used. In this case, it becomes such a configuration that the piezoelectric element 206 is replaced with the heating element.

[0026]

Further, in a nozzle part 210 for droplet emission, a wet property between droplets and the liquid chamber flow path 202, the auxiliary liquid chamber 203, the fluid resistance part 204, the compressing chamber 205, and further, the droplet emitting hole 207 becomes important. On that account, it would also be fine if a carbon film, a resin film, etc. (not shown in the figure) for adjusting the wet property with a material is formed in respective flow paths.

[0027]

By the above-described means, it is possible to emit droplets on a processed substrate. In the droplet emitting system, there are a so-called sequential system (dispenser system) in which droplets are emitted continuously to form a continuous line form pattern, and a so-called on-demand system in which droplets are emitted in a dot form manner, and in an apparatus configuration in the invention, the on-demand system was shown, but it is also possible to use a head by use of the sequential system.

[0028]

Fig.2(B) is a perspective view which shows a scanning example at the time of droplet emission of the head 201. Since the head 201 can move arbitrarily in X and Y directions, it is also possible to form a key type wiring pattern 211 as shown in Fig.2(B), by emitting droplets while overlapping them in a dot form. As a matter of course, in an area where there is no necessity to emit droplets, it is also possible not to emit droplets by not inputting a signal to the piezoelectric element 205.

[0029]

Figs.3(A) to 3(C) each illustrate a bottom part of the head in Figs.2. Fig.3(A) is of such a basic arrangement that one droplet emitting hole 302 is disposed on a bottom surface of the head 301. In contrast to this, in Fig.3(B), it is of a so-called cluster form arrangement in which the droplet emitting holes 402 on a head bottom part

401 are increased to three points so as to configure a triangle. If the head 401 as shown in Fig.3(B) is used, it is possible to draw a plurality of continuous patterns etc., and also, to emit droplets to a plurality of places at the same time, or with an interval of time, and therefore, it becomes possible to reduce a scanning amount of the head. In Fig.3(C), it is of such an arrangement that droplet emitting holes are disposed above and below. In this arrangement, after droplet emission from upper droplet emitting hole 502, similar droplets are emitted to a similar place from a lower droplet emitting hole 503 with an interval of time, and therefore, before droplets on the substrate, which have been already emitted, are dried and solidified, it is possible to further accumulate identical droplets thickly. Further, in a case where the upper droplet emitting hole is clogged with droplets or the like, the lower droplet emitting hole can be made to function as a backup.

[0030]

Further, by disposing the emitting hole 207 at a slant to the object 102 to be processed, it would be also fine if droplets are emitted at a slant to the object to be processed. It would be also fine if the slant is slanted by a slanting mechanism with which the head 106 or the head support part 107a is equipped, and it would be also fine if a shape of the droplet emitting hole 207 in the head 106 is tapered, and droplets are emitted in a slanted manner. By the above-described slanted emission of droplets, a wet property with droplets which are emitted to a surface of the object 102 to be processed is controlled, and thereby, it becomes possible to control shapes of droplets at the time when they landed in the object to be processed.

[0031]

As a composition which is used as droplets of the above-described dot form droplet emitting apparatus, it is possible to use a photosensitive resist, a paste form metal material or an organic liquid solution such as electric conductive polymer, in which the paste form metal is dispersed, an organic liquid solution such as electric conductive polymer, in which an ultra-fine particle form metal material and the above-described material are further dispersed, and so on. In particular, particles of several  $\mu\text{m}$  to sub $\mu\text{m}$ , ultra-fine particles of nm level, or particles containing both of them can be used for the ultra-fine particle form metal material is a metal material which is processed to fine, and any one of, or both of the particles are dispersed in an

organic liquid solution, to be used. In a case where the ultra-fine particle form metal material was used as the composition, there is a necessity to select the ultra-fine particle form metal material with a enough size to come around into a contact hole and a narrow groove part, etc. It would be fine if these droplets are heated and dried at the time of droplet land-in, by use of a heating mechanism (not shown in the figure) which is attached to the carrier table 103 of the substrate, and it would be also fine if, after land-in of droplets in a necessary area is completed, or after all droplet emission processing is completed, they are heated and dried. The above-described resist is baked by heat treatment, and can be used as a mask at the time of etching. Further, the above-described organic liquid solution which includes the ultra-fine particle form metal material can be used as metal wiring, when the organic liquid solution is volatilized by heat treatment and ultra-fine particle form metals are coupled.

[0032]

The above-described dot form droplet emitting apparatus can carry out under atmospheric pressure or in the vicinity of atmospheric pressure, unlike a resist coating process, a film formation and etching process in a conventional photolithography process. The vicinity of atmospheric pressure shows a pressure range of 5Torr to 800Torr. In particular, it is also possible for the above-described droplet emitting apparatus to carry out emission of droplets under positive pressure of an extent of 800Torr.

[0033]

By use of the above-described dot form droplet emitting apparatus, the resist pattern 1003 is formed in the embodiment mode 1 of the invention, and thereby, a resist is used only for a necessary place for forming a wiring pattern, and therefore, as compared to a spin coating method which is used in the prior art, it becomes possible to dramatically reduce quantity of the resist consumed.

[0034]

Next, a plasma processing apparatus, which is used in the embodiment mode 1, will be explained with reference to Fig.4. Fig.4(A) is a top view of one example of the plasma processing apparatus which is used in the invention, and Fig.4(B) is a cross-section view. In these figures, in a cassette chamber 16, an object 13 to be processed, such as a glass substrate with a desired size, and a resin substrate typified by

a plastic substrate, is set. As a carrying system of the object 13 to be processed, horizontal carrying is cited, but in a case of using a meter square substrate of a fifth generation or later, with the aim of reduction of an occupied area of a carrying machine, vertical carrying with a substrate being placed vertically may be carried out.

5 [0035]

In a carrier chamber 17, the object 13 to be processed, which is disposed in the cassette chamber 16, is carried in a plasma processing chamber 18 by a carrier mechanism (robot arm) 20. In the plasma processing chamber 18 which is located next to the carrier chamber 17, provided are air flow control means 10, plasma  
10 generating means 12 which has a cylindrical electrode, rails 14a, 14b for moving the plasma generating means 12, moving means 15 for carrying out movement of the object 13 to be processed, and so on. A well-known heating means (not shown in the figure) such as a lamp is provided, if necessary.

[0036]

15 The air flow control means 10 is a thing which is aimed at dust control, and carries out control of an air flow so as to be shielded from outside air, by use of inert gas which is emitted from a blowout outlet 23. The plasma generating means 12 moves to a predetermined position, by the rail 14a which is disposed in a carrying direction of the object 13 to be processed, and also, the rail 14b which is disposed in a direction which  
20 is perpendicular to the carrying direction. F, the object 13 to be processed moves in the carrying direction by the moving means 15. On the occasion of actually carrying out plasma processing, any one of the plasma generating means 12 or the object 13 to be processed may be moved.

[0037]

25 Then, details of the plasma generating means 12 will be explained by use of Fig.5. Fig.5(A) shows a perspective view of the plasma generating means 12 which has a cylindrical electrode, and Figs.25(B) to (D) show cross-section views of the cylindrical electrode.

[0038]

30 In Fig.5(B), dotted lines show paths of gas, and 21, 22 designate electrodes which comprise a material having electric conductivity, such as aluminum and copper, and a first electrode 21 is connected to a power supply (high frequency power supply)



29. Meanwhile, it would be also fine if a cooling system (not shown in the figure) for circulating cooling water is connected to the first electrode 21. When the cooling system is disposed, prevented is heating in a case of continuously carrying out surface processing, by circulation of cooling water, and improvement of efficiency due to continuous processing becomes possible. A second electrode 22 has a shape surrounding a periphery of the first electrode 21, and is electrically grounded. And, the first electrode 21 and the second electrode 22 have cylindrical forms having nozzle form narrow mouths for gas, at their front edge. In a space between both electrodes of this first electrode 21 and the second electrode 22, process gas is supplied through a valve 27 from gas supply means (gas cylinder) 31. And, an atmosphere in the space is replaced and in this status, when a high frequency voltage (10 to 500MHz) is applied to the first electrode 21 by the high frequency power supply 29, plasma is generated in the space. And, when a reactive gas flow including a chemically active excitation seed such as ion and radical, which is generated by this plasma, is irradiated toward a surface of the object 13 to be processed, it is possible to carry out local plasma surface processing at a predetermined position, on the surface of the object 13 to be processed. At this time, a distance between the surface of the object 13 to be processed and the narrow mouth which becomes an emission outlet of process gas is 3mm or less, preferably 1mm or less, more preferably 0.5mm or less. In particular, it would be also fine if a sensor for measuring a distance is attached, and the distance between the surface of the object 13 to be processed and the narrow mouth which becomes the emission outlet of process gas is controlled.

[0039]

Meanwhile, gas for process, which is filled in the gas supply means (gas cylinder) 31, is properly set up in tune with a type of surface processing which is carried out in a processing chamber. The discharged gas is collected in an air discharging system 30 through a filter 33 for removing dusts mixed in gas, and the valve 27. Further, these collected discharged gas are purified and circulated, to reuse the gas, and thereby, it is also possible to utilize the gas effectively.

[0040]

A cylindrical form plasma generating means 12, which has a different cross-section from Fig.5(B), is shown in Figs.25(C)(D). Fig.5(C) has such a shape that

the first electrode 21 is longer than the second electrode 22, and the first electrode 21 is of an acute angle, and also, Fig.5(D) has such a shape that an ionized gas flow, which is generated between the first electrode 21 and the second electrode 22, is emitted to an outside.

5 [0041]

The invention, which uses the plasma processing apparatus operating under atmospheric pressure or the vicinity of atmospheric pressure (means a pressure range of 5Torr to 800Torr.), does not require time for vacuuming and atmospheric air release, which are required in a decompressing apparatus, and does not require to dispose a  
10 complex vacuum system. In particular, in a case of using a large size substrate, a chamber also grows in size necessarily, and when an inside of the chamber runs into a reduced pressure status, processing time is required, and therefore, this apparatus, which is operated under atmospheric pressure or the vicinity of atmospheric pressure, is useful, and it becomes possible to reduce production cost.

15 [0042]

From the foregoing, by carrying out etching of the electric conductive film, and ashing of the resist in Embodiment Mode 1 of the invention, rapid processing, in which a conventional air discharging procedure is omitted, becomes possible. Since an air discharging system is unnecessary, as compared to a case of using a conventional  
20 apparatus which has decompression processing, manufacture could be carried out with a reduced space.

[0043]

A manufacturing process of the wiring pattern in Embodiment Mode 1 is a process which uses the line form droplet emitting apparatus and the plasma processing  
25 apparatus at the same time. It is also possible to use either means and leave the other to conventional means, but having regard to space saving, rapid processing, low cost, etc., it is desirable to use the dot form droplet emitting means of the invention, and the atmospheric pressure plasma processing means of the invention at the same time. Alternatively, it would be also fine if it is combined with a method of using the  
30 aforementioned line form droplet emitting apparatus of the present invention, and the local plasma processing apparatus.

[0044]

(Embodiment Mode 2)

In Embodiment Mode 2 of the invention, a wiring pattern is manufactured on a glass substrate with a desired size in the same manner as Embodiment Mode 1; however, it is a feature that only the plasma processing apparatus is used without using the line form droplet emitting means, unlike Embodiment Mode 1. Meanwhile, here, the plasma processing apparatus, which was cited in Embodiment Mode 1, is used, but the plasma processing apparatus for carrying out local plasma processing, which was cited in the embodiment mode 2, may be used.

[0045]

First, by use of a publicly known sputter processing method, an electric conductive film 1012, which becomes wiring, is formed on a substrate 1011 to be processed (Figs.7(A),(B)). Next, by use of the atmospheric pressure plasma processing apparatus of the present invention used in Embodiment mode 1, the electric conductive film 1012 is etched (Fig.7(C)). By separating the electric conductive film into pattern forms, a wiring 1013 is formed (Fig.7(D)).

[0046]

In Embodiment Mode 2 of the invention, it is possible to simplify processes, by such a portion that a forming process of a resist pattern, which was shown in the embodiment mode 1 is omitted. However, since the resist pattern does not exist, an edge of a wiring which is formed is influenced a great deal by a diameter of a gas emitting opening of an atmospheric pressure plasma processing apparatus. Therefore, Embodiment Mode 2 is suitable for formation of a wiring pattern which has a scale of such an extent that this influence is negligible.

[0047]

By the above-described manufacturing process of the wiring pattern, in the same manner as the embodiment mode 1, rapid processing becomes possible, in which an conventional air discharging procedure is omitted. Since the air discharging system is unnecessary, as compared to a case of using a conventional apparatus which has depression processing, manufacture could be carried out with a reduced space.

[0048]

(Embodiment Mode 3)

In Embodiment Mode 2 of the invention is, in the same manner as the embodiment modes 1, 2, a wiring pattern is manufactured on a glass substrate of a desired size, and characterized in that, after a groove is formed in a wiring forming part, droplets are emitted to the groove portion by use of a dot form droplet emitting apparatus, of the invention.

[0049]

First, on a substrate 1021 to be processed, an insulating film 1022 for forming a groove is formed by use of a publicly known thermal oxidation process or a CVD method (Chemical Vapor Deposition method) etc.(Figs.8(A),(B)). The insulating film 1022 may be an inorganic insulating film such as a silicon oxide film and a silicon nitride film, and may be also an organic insulating film such as acrylic and polyimide.

[0050]

Next, by use of a publicly known photolithography process, a groove 1023 is formed on the insulating film 1022 (Fig.8(C)). The groove 1023 is a depression which is disposed, on the occasion of emitting droplets, which are a wiring material for preventing them from being expanded from a land-in place at later time, and formed so as to become a shape of a wiring pattern. In the groove forming in the insulating film 1022, it would be fine if the insulating film 1022, which is comparable to an area for carrying out groove formation, is removed completely, and it would also be fine if the insulating film is remained under the groove forming area.

[0051]

The groove 1023 may be formed in a line form, and may be also a circular depression. In particular, in forming the circular depression, an electric conductive film is disposed under the insulating film 1022, and the insulating film in the depression forming area is removed completely, and thereby, it is also used as a contact hole to an electric conductive film under the insulating film 1022. A side wall of the groove 1023 may have a tapered angle, and may be also perpendicular to a surface of an object to be processed.

[0052]

Droplets of a wiring material are emitted by use of the dot form droplet emitting apparatus of the present invention so as to fill this groove 1023. A droplet emitting head 1024 of the dot form droplet emitting apparatus relatively scans the

substrate 1021 to be processed and also moves in a direction perpendicular to the scan direction, as shown by an arrow in Fig.8(D). Droplets are emitted when the droplet emitting head 1024 is immediately above the groove 1023 (Fig.8(D)). As a result of that, the groove part 1023 is filled with droplets, and a wiring pattern 1025 is drawn (Fig.8(E)).

[0053]

By designing a width and a depth of the groove part 1023 in tune with a diameter of droplet, it is possible to fill the groove part with droplets, with high accuracy. There is a necessity to design the width and the depth of the groove part 1023, having regard to a material of droplets.

[0054]

The groove 123 is formed by a known method in Embodiment Mode 3; however, the atmospheric pressure plasma processing apparatus may be used instead.

[0055]

By the above-described wiring pattern forming process, in the same manner as the embodiment modes, rapid processing, in which a conventional air discharging procedure is omitted, becomes possible. Since an air discharging system is unnecessary, as compared to a case of using a conventional apparatus which has depression processing, manufacture can be carried out with a reduced space. Further, in Embodiment Mode 3, since the groove is formed in a wiring forming part, it becomes possible to use a material with low viscosity, for the droplet emitting head of the droplet emitting apparatus. Further, it is also possible to manufacture a processing surface with high flatness, by selecting a droplet material, a work dimension of the groove part, etc. in an appropriate manner.

[0056]

(Embodiment Mode 4)

Embodiment mode 5 of the invention is characterized in that a dot form droplet emitting apparatus is used for improving adhesion between laminated films, to draw a matrix form pattern.

[0057]

With reference to accompanying drawings, the process will be explained. On a substrate 1031 to be processed, droplets 1032 are emitted in a matrix form, by use of a

droplet emitting apparatus (Figs.9(A),(B)). The substrate 1031 to be processed may be a glass substrate, and may be also a substrate which has a laminated film. Subsequently, on the substrate 1031 to be processed and the droplets 1032, a thin film 1033 is laminated. The thin film 3033 may be an inorganic thin film such as a silicon oxide film and a silicon nitride film, and may be also an organic thin film. he thin film 1033 may be an organic planarized film, and may be also an alignment film or a seal material, which are applied in a post-process of LCD panels.

[0058]

As above, by forming a matrix form pattern by use of the line form droplet emitting apparatus or the dot form droplet emitting apparatus, it becomes possible to improve adhesion between laminated films.

[0059]

[Embodiments ]

(Embodiment 1)

Embodiment 1 will describe a manufacturing method of a display device of the present invention using a plasma processing method of by which local plasma processing is performed, which includes a droplet emitting apparatus which has a droplet emitting head provided with one or a plurality of droplet emitting holes, and a plasma processing apparatus which has a plasma generating means generating plasma under atmospheric pressure or the vicinity of atmospheric pressure, will be explained. Hereinafter, with reference to drawings, embodiments of the invention will be described. Embodiment 1 of the invention is a manufacturing method of a channel stop type thin film transistor (TFT).

[0060]

On a substrate 2001 to be processed, which uses various materials such as glass, quartz, semiconductor, plastic, plastic film, metal, glass epoxy resin, and ceramic, a composition having publicly known electric conductivity is emitted by use of a dot form droplet emitting apparatus of the invention, and thereby, a gate electrode and wiring 2002, a capacitance electrode and wiring 2003 are formed (Fig.10(A)). It is desirable that a line width of the gate electrode and wiring 2002 is drawn with a range of 5 to 50 $\mu$ m. Next, by applying heat treatment etc. to the substrate on which the gate electrode and wiring 2002, the capacitance electrode and wiring 2003 were formed,

liquid solution of droplets is evaporated, to reduce viscosity of its composition. Meanwhile, the heat treatment may be carried out at any time such as at the time of droplet emission due by to the dot form droplet emitting apparatus, after droplet emission in an arbitrary area, or after all processes are finished.

5 [0061]

Subsequently, by use of the dot form droplet emitting apparatus, resists 2004, 2005 are emitted so as to cover the gate electrode and wiring 2002, the capacitance electrode and wiring 2003, which have been emitted in the above-described process (Fig.10(B)). After that, by use of a publicly known photolithography process, the  
10 resists are patterned (Fig.10(C)). Meanwhile, on the occasion of emitting resists by the dot form droplet emitting apparatus, a resist pattern may be formed directly, by the dot form droplet emitting apparatus, without using the publicly known photolithography process.

[0062]

15 Next, by use of the atmospheric pressure plasma apparatus of the present invention, dot form plasma is formed, and etching of the gate electrode and wiring 2002, and the capacitance electrode and wiring 2003 is carried out, and thereafter, by use of an atmospheric pressure plasma apparatus of the invention in the same manner, the resist is removed by ashing (Figs.11(A),(B)).

20 [0063]

By the above-described processes, the gate electrode and wiring 2002, and the capacitance electrode and wiring 2003 are formed. Meanwhile, as a material for forming the gate electrode and wiring 2002, and the capacitance electrode and wiring 2003, it is possible to use an electric conductive material such as molybdenum (Mo),  
25 titanium (Ti), tantalum (Ta), tungsten (W), chromium (Cr), aluminum (Al), copper (Cu), aluminum (Al) including neodymium (Nd) etc., and a laminated layer of these or alloy.

[0064]

After that, by use of a publicly known method such as a CVD method (Chemical Vapor Deposition method), a gate insulating film 2006 is formed (Fig.11(C)).  
30 In this embodiment, as the gate insulating film 2006, a silicon nitride film is formed by the CVD method under atmospheric pressure, but it would be also fine if a silicon oxide film or a laminated layer configuration of these is formed.

[0065]

Further, by use of a publicly known method (sputtering method, LP (reduced pressure) CVD method, plasma CVD method, etc.), an active semiconductor layer 2007 is formed as a film with a thickness of 25 to 80nm (preferably, 30 to 60nm). The active semiconductor layer 2007 is an amorphous semiconductor film typified by an amorphous silicon film, and is formed on a whole surface of the substrate 2001 to be processed.

[0066]

Next, after a silicon nitride film etc. is formed on a whole surface of the substrate to be processed, patterning is carried out and thereby, a channel protective film (etching stop film) 2008 is formed (Fig.12(B)). For formation of the channel protective film 2008, it would be fine if a resist is emitted by use of the dot form droplet emitting apparatus of the present invention, and it would be also fine if a publicly known photolithography process is used.

[0067]

Subsequently, an amorphous semiconductor film 2009, in which an impurity element for giving n-type electric conductivity is added, is formed on a whole surface of the substrate to be processed (Fig.12(C)).

[0068]

After that, by use of the dot form droplet emitting apparatus of the invention, source/drain electrodes and wirings 2010, 2011 are formed (Fig.13(A)). Meanwhile, the source/drain electrodes and wirings 2010, 2011 may be patterned in the same manner as the gate electrode and wiring 2002, and the capacitance electrode and wiring 2003, which are shown in Fig.10(A) through Fig.11(B). A line width of the source/drain electrodes and wirings 2010, 2011 is drawn with a range of 5 to 25 $\mu$ m. As a material for forming the source/drain electrodes and wirings 2010, 2011, it is possible to use an electric conductive material such as molybdenum (Mo), titanium (Ti), tantalum (Ta), tungsten (W), chromium (Cr), aluminum (Al), copper (Cu), aluminum (Al) including neodymium (Nd) etc., and a laminated layer of these or alloy, in the same manner as the gate electrode, wiring.

[0069]

After that, by use of the source/drain electrodes and wirings 2010, 2011 as a



mask, the amorphous semiconductor film 2009, in which an impurity element for giving n-type electric conductivity is added, and the active semiconductor layer 2007 are etched by forming dot form plasma through the use of the atmospheric pressure plasma apparatus of the present invention, and by scanning this (Fig.13(B)). In a channel forming part, the active layer semiconductor layer 2007 under the channel protective film (etching stop film) 2008 is not etched, by the channel protective film (etching stop film) 2008.

[0070]

Further, by use of a publicly known method such as a CVD method, a protective film 2012 is formed (Fig.13(C)). In this embodiment, as the protective film 2012, a silicon nitride film is formed under atmospheric pressure by the CVD method, but it would be also fine if a silicon oxide film or a laminated layer configuration of these is formed. It is also possible to use an organic resin film such as an acrylic film.

[0071]

After that, after a resist is emitted by the line form droplet emitting apparatus, the resist is patterned by a publicly known photolithography process (not shown in the figure). Further, by use of the atmospheric pressure plasma apparatus of the present invention, dot form plasma is formed, and etching of the protective film 2012 is carried out, and a contact hole 2013 is formed (Fig.14(A)). It is desirable that a diameter of the contact hole 2013 is formed with a range of 2.5 to 30 $\mu$ m, by adjusting a gas flow and a high frequency voltage, etc. to be applied between electrodes.

[0072]

After that, by the dot form droplet emitting apparatus, a pixel electrode 2014 is formed (Fig.14(B)). The pixel electrode 2014 may be drawn directly by the dot form droplet emitting apparatus, and may be also formed by carrying out patterning in the same manner as the gate electrode and wiring 2002, and the capacitance electrode and wiring 2003, which are shown in Fig.10(A) through Fig.11(B). As a material of the pixel electrode 2014, it is possible to use a transparent electric conductive film such as ITO (indium oxide tin oxide alloy), indium oxide zinc oxide alloy ( $\text{In}_2\text{O}_3$  - ZnO), and zinc oxide (ZnO), or an electric conductive material such as molybdenum (Mo), titanium (Ti), tantalum (Ta), tungsten (W), chromium (Cr), aluminum (Al), copper (Cu), aluminum (Al) including neodymium (Nd) etc., and a laminated layer of these or alloy.

[0073]

In Embodiment 1, a manufacturing example of the channel stop type thin film transistor was shown, but it is needless to say that a channel etch type thin film transistor, which does not use a channel stop film, may be manufactured by the  
5 above-described apparatus.

[0074]

(Embodiment 2)

A manufacturing method of a display device of the invention, which uses the above-described droplet emitting apparatus which has the droplet emitting head in  
10 which one or a plurality of circular droplet emitting holes are disposed, and the plasma processing apparatus which has the plasma generating system generating plasma under atmospheric pressure, will be explained. In this embodiment, it is characterized by manufacturing a thin film transistor (TFT), without using a photolithography process which uses a resist mask at all. Hereinafter, with reference to the drawings, an  
15 embodiment of the invention will be explained. Embodiment 2 of the invention is a manufacturing method of a channel stop type thin film transistor (TFT).

[0075]

On a substrate 3001 to be processed, which uses various materials such as glass, quartz, semiconductor, plastic, plastic film, metal, glass epoxy resin, and ceramic, a  
20 composition having publicly known electric conductivity is emitted on a necessary place, by use of a dot form droplet emitting apparatus of the invention, and thereby, a gate electrode and wiring 3002, a capacitance electrode and wiring 3003 are formed (Fig.15(A)). It is desirable that a line width of the gate electrode and wiring 3002 is drawn with a range of 5 to 50 $\mu$ m. Next, by applying heat treatment etc. to the  
25 substrate on which the gate electrode and wiring 3002, the capacitance electrode and wiring 3003 are formed, liquid solution of droplets is evaporated, to decrease viscosity of its composition. Meanwhile, the heat treatment may be carried out at any time such as at the time of droplet emission by the dot form droplet emitting apparatus, after droplet emission in an arbitrary area, or after all processes are finished.

[0076]

In this embodiment, it is characterized by directly using a pattern of a composition which is drawn by the dot form droplet emitting apparatus, as the gate

electrode and wiring, without carrying out a photolithography process. By the above-described process, the gate electrode and wiring 3002, the capacitance electrode and wiring 3003 are formed. Meanwhile, as a material which forms the gate electrode and wiring 3002, the capacitance electrode and wiring 3003, it is possible to use an electric conductive material such as molybdenum (Mo), titanium (Ti), tantalum (Ta), tungsten (W), chromium (Cr), aluminum (Al), copper (Cu), aluminum (Al) including neodymium (Nd) etc., and a laminated layer of these or alloy.

[0077]

After that, by use of a publicly known method such as a CVD method (Chemical Vapor Deposition method), a gate insulating film 3004 is formed (Fig.15(B)). In the embodiment, as the gate insulating film 3004, a silicon nitride film is formed by the CVD method under atmospheric pressure, but it would be also fine if a silicon oxide film or a laminated layer configuration of these is formed.

[0078]

Further, by use of a publicly known method (sputtering method, LP (reduced pressure) CVD method, plasma CVD method, etc.), an active semiconductor layer 3005 is formed as a film with a thickness of 25 to 80nm (preferably, 30 to 60nm). The active semiconductor layer 3005 is an amorphous semiconductor film typified by an amorphous silicon film, and formed on a whole surface of the substrate 3001 to be processed (Fig.15(C)).

[0079]

Next, a channel protective film (etching stop film) 3006 is formed in a channel forming area of the substrate to be processed (Fig.16(A)). For formation of the channel protective film 3006, a composition having a characteristic of high resistance of an organic resin film etc. such as polyimide and acrylic films, is emitted by use of the dot form droplet emitting apparatus. Further, for the channel protective film, it would be also fine if silica glass which is widely used as SOG (Spin On Glass) solution, alkyl-siloxane-polymer, alkyl-silsesquioxane-polymer (MSQ), hydrogenated silsesquioxane-polymer (HSQ), hydrogenated alkyl-silsesquioxane-polymer (HOSP), etc. are used.

[0080]

Subsequently, an amorphous semiconductor film 3007, in which an impurity

element for giving n-type electric conductivity is added, is formed on a whole surface of the substrate to be processed (Fig.16(B)).

[0081]

After that, by use of the dot form droplet emitting apparatus of the invention,  
5 source/drain electrodes and wirings 3008, 3009 are formed (Fig.16(C)). Also in this case, a wiring pattern is formed by emitting droplets, which become a wiring, directly to the substrate to be processed, and therefore, a photolithography process is not necessary. A line width of the source/drain electrodes and wirings 3008, 3009 is drawn with a range of 5 to 25 $\mu$ m. As a material for forming the source/drain electrodes and wirings  
10 3008, 3009, it is possible to use an electric conductive material such as molybdenum (Mo), titanium (Ti), tantalum (Ta), tungsten (W), chromium (Cr), aluminum (Al), copper (Cu), aluminum (Al) including neodymium (Nd) etc., and a laminated layer of these or alloy, in the same manner as the gate electrode, wiring.

[0082]

15 After that, by use of the source/drain electrodes and wirings 3008, 3009 as a mask, the amorphous semiconductor film 3007, in which an impurity element for giving n-type electric conductivity is added, and the active semiconductor layer 3005 are etched by forming local plasma using the plasma processing apparatus which has a plasma generating system generating plasma under atmospheric pressure or the vicinity  
20 of the atmospheric pressure and performs local plasma processing, and by scanning is preformed using this (Fig.17(A)). In a channel forming part, the active semiconductor layer 3005 under the channel protective film (etching stop film) 3006 is not etched, by the channel protective film (etching stop film) 3006.

[0083]

25 Further, by use of a publicly known method such as a CVD method, a protective film 3010 is formed (Fig.17(B)). In the embodiment, as the protective film 3010, a silicon nitride film is formed under atmospheric pressure by the CVD method, but it would be also fine if a silicon oxide film or a laminated layer configuration of these is formed. It is also possible to use an organic resin film such as an acrylic film.

30 [0084]

After that, by use of the plasma processing apparatus which has the plasma generating system generating plasma under atmospheric pressure, dot form local plasma

is formed, and local etching of the protective film 3010, which is not covered with the resist pattern 3012, is carried out; thereby a contact hole 3011 is formed (Fig.17(C)). It is desirable that a diameter of the contact hole 3013 is formed with a range of 2.5 to 30 $\mu$ m, by adjusting a gas flow and a high frequency voltage, etc. to be applied between electrodes.

[0085]

After that, by a publicity of sputter or the like, a material, which becomes a pixel electrode, is formed as a film on a whole surface of an object to be processed. As a material of the pixel electrode, it is possible to use a transparent electric conductive film such as ITO (indium oxide tin oxide alloy), indium oxide zinc oxide alloy ( $\text{In}_2\text{O}_3$  - ZnO), and zinc oxide (ZnO), or an electric conductive material such as molybdenum (Mo), titanium (Ti), tantalum (Ta), tungsten (W), chromium (Cr), aluminum (Al), copper (Cu), aluminum (Al) including neodymium (Nd) etc., and a laminated layer of these or alloy. Subsequently, a resist is emitted by the dot form droplet emitting apparatus, and a pixel electrode forming area is covered with a resist pattern 3013 (Fig.18(B)). Further, by use of the plasma processing apparatus which has plasma generating system generating plasma under atmospheric pressure, line form plasma is formed, and a pixel electrode material, which is not covered by a resist pattern 3013, is etched and removed (Fig.18(C)). And, by use of the plasma processing apparatus which has plasma generating system under atmospheric pressure, the resist pattern 3013 is removed by ashing, and thereby, a pixel electrode 3012 is formed.

[0086]

In the embodiment 2, the example of manufacturing the channel stop type thin film transistor was shown, without using a photo mask which is used in a conventional photolithography process, but it is needless to say that a channel etch type thin film transistor, which does not use a channel stop film, may be manufactured by the above-described apparatus.

[0087]

In the embodiment 1 and the embodiment 2, the manufacturing method of the display device was shown, but it is also possible to manufacture a display device which uses a crystalline semiconductor typified by polysilicon by use of a similar manufacturing method.

[0088]

Also, the above-described display apparatus, which used the amorphous semiconductor and the crystalline semiconductor, is a liquid crystal display device, but it would be also fine if a similar manufacturing method is applied to a light emitting display device (EL (Electro-Luminescence) display device).

[0089]

(Embodiment 3)

By use of the invention, it is possible to complete various electric appliances. Its concrete example will be explained by use of Figs.20.

[0090]

Fig.20(A) is of a display device apparatus which has a large size display part of for example, 20 to 80 inches, and includes a housing 4001, a support table 4002, a display part 4003, a speaker part 4004, a video input terminal 4005, etc. The invention is applied to a manufacture of the display part 4003. It is suitable to manufacture such large size display apparatus by use of a large size substrate of such meter square as so-called fifth generation (1000X1200mm<sup>2</sup>), sixth generation (1400X1600mm<sup>2</sup>), and seventh generation (1500X1800mm<sup>2</sup>).

[0091]

Fig.20(B) is of a notebook type personal computer, and includes a main body 4201, a housing 4202, a display part 4203, a keyboard 4204, an external connection port 4205, a pointing mouse 4206, etc. The invention is applied to a manufacture of the display part 4203.

[0092]

Fig.20(C) is of a portable type image reproducing apparatus (concretely speaking, DVD reproducing apparatus) which is equipped with a recording medium, and includes a main body 4401, a housing 4402, a display part A 4403, a display part B 4404, a recording medium (DVD etc.) reading part 4405, an operation key 4406, a speaker part 4407, etc. The display part A 4403 displays mainly image information, and the display B 4404 displays mainly textual information, and the invention is applied to a manufacture of these display part A, B 4403, 4404.

[0093]

As above, an applicable scope of the invention is extremely wide, and it is

possible to apply the invention to a manufacture of an electric appliance in a every field. Further, it is possible to freely combine the above-described embodiment modes and embodiments.

[0094]

5 [Effect of the Invention]

A display device is manufactured by use of a dot form droplet emitting means and a plasma processing means generating means under atmospheric pressure, and thereby, it becomes possible to reduce waste of a material (material of wiring etc. in droplet emitting means, and gas in plasma processing means). At the same time, it becomes possible to reduce production cost. Further, by using the apparatus, it becomes possible to realize simplification of processes, small size of an apparatus and a manufacturing factory, a manufacturing facility, and also, speed-up of processes. Further, it is possible to reduce energy, such that it is possible to simplify an equipment of an air discharging system which is required in the prior art, and therefore, it is possible to reduce environmental burdens.

[0095]

Moreover, the invention is a manufacturing process which responds to a large size substrate, and various problems such as growing in size of an apparatus which comes up with growing in size of a conventional apparatus, and increase of processing time are solved.

[Brief Description of the Drawings]

[Fig. 1] A perspective view showing a configuration of a dot form droplet emitting apparatus of the invention.

[Figs. 2] (A) and (B) are diagrams showing a configuration of a dot form droplet emitting part of a dot form droplet emitting apparatus of the invention.

[Figs. 3] (A) to (C) are diagrams each showing a bottom surface of a droplet emitting part of a dot form droplet emitting apparatus of the invention.

[Figs. 4] (A) and (B) are diagrams each showing a configuration of an atmospheric pressure plasma processing apparatus of the invention.

[Figs. 5] (A) to (D) are diagrams each showing a configuration of a plasma generating portion of an atmospheric pressure plasma processing apparatus of the invention.

[Figs. 6] (A) to (F) are schematic perspective views showing processing steps of Embodiment Mode 1 of the invention.

[Figs. 7] (A) to (D) are schematic perspective views showing processing steps of Embodiment Mode 2 of the invention.

5 [Figs. 8] (A) to (E) are schematic perspective views showing processing steps of Embodiment Mode 3 of the invention.

[Figs. 9] (A) to (C) are schematic perspective views showing processing steps of Embodiment Mode 4 of the invention.

10 [Figs. 10] (A) to (C) are schematic views showing a manufacturing process of an embodiment of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

[Figs. 11] (A) to (C) are schematic views showing a manufacturing process of an embodiment of the invention, each of the diagrams on the left shows a top views, and  
15 each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

[Figs. 12] (A) to (C) are schematic views showing a manufacturing process of an embodiment of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on  
20 the left taken along line a-a'.

[Figs. 13] (A) to (C) are schematic views showing a manufacturing process of an embodiment of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

25 [Figs. 14] (A) and (B) are schematic views showing a manufacturing process of an embodiment of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

[Figs. 15] (A) to (C) are schematic views showing a manufacturing process  
30 of Embodiment 2 of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.



[Figs. 16] (A) to (C) are schematic views showing a manufacturing process of Embodiment 2 of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

5 [Figs. 17] (A) to (C) are schematic views showing a manufacturing process of Embodiment 2 of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

10 [Figs. 18] (A) to (C) are schematic views showing a manufacturing process of Embodiment 2 of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

15 [Figs. 19] (A) is a schematic view showing a manufacturing process of Embodiment 2 of the invention, each of the diagrams on the left shows a top views, and each of the diagrams on the right shows a cross-sectional view of the diagrams on the left taken along line a-a'.

[Figs. 20] (A) to (C) are diagrams showing electronic devices of Embodiment Mode 3 of the invention.

[Name of Document]      Abstract

[Summary]

[Problem]

5      In a wiring manufacturing process which uses conventional photolithography, most of resist and wiring material, or process gas which is necessary at the time of plasma processing, etc. is wasted. Further, since air discharging means such as a vacuum apparatus is necessary, an entire apparatus grows in size, and therefore, production cost increases with growing in size of a processing substrate.

[Solving Means]

10      Means which directly emits a resist or a wiring material as droplets on a portion of a substrate form to draw a pattern is applied.

[Selected Drawing] FIG. 1